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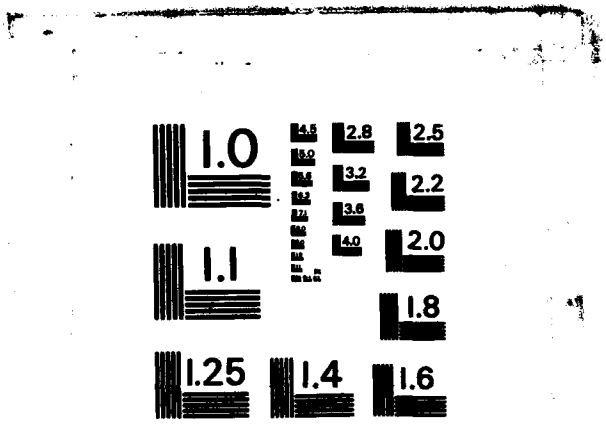

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ABSTRACT

NORDA's Remote Sensing Branch will conduct an operational demonstration as part of the GEOSAT-A Ocean Applications Program (GOAP). The purpose of the demonstration is to prove that oceanographic products can be derived from altimeter data in near-real-time. This technical note describes the information processing system that will be used for this task, and plans for its development and testing. It also covers plans for the operation of the system, personnel assignments and training, evaluation of the products, and eventual transfer of the operations to FNOC.

ACKNOWLEDGMENTS

The preparation of this technical note was part of the work performed for the Satellite Oceanography Tactical Applications (SOTA) Program, under Program Element 63704N. Sponsorship was provided by CAPT D. C. Honhart, CNO/OP-952E. The SOTA Program is managed by Mr. A. E. Pressman, NORDA Code 335. The work was performed during the period June 1982 - March 1983.

SECTION 1. INTRODUCTION

1.1 Purpose of Test Plan

This test plan has been prepared in order to document the GEOSAT-A activities that will be performed by NORDA, Remote Sensing Branch. It is written:

a. To provide an overview of the GEOSAT-A Ocean Applications Program (GOAP) information processing and a description of the hardware and software that will be used.

b. To present an orderly schedule of events, specification of organizational requirements, the method of testing, and a schedule of user orientation.

c. To establish a comprehensive test plan and to communicate the nature and extent of the tests deemed necessary to provide a basis for evaluation of the system.

1.2 Project References

(a) "GEOSAT-A Ocean Applications Program APL/NORDA Data Link Program Plan," JHU/APL Document SDO-6352.1, July 1982; JHU/APL Document SDO-6352.2, January 1983.

(b) "GEOSAT-A Information Processing System (GIPS) Conceptual Design," JPL Document, December 16, 1982.

1.3 Organizational Involvement

Table 1.1 is a matrix that shows action organizations, actions that have been or will be performed, and time frames.

SECTION 2. DEVELOPMENT TEST ACTIVITY

2.1 Background

NORDA, under separate funding, is procuring a satellite receiving/processing facility. That processing facility will be upgraded to support GOAP by the purchase of two (2) Gould SEL 32/27 32-bit minicomputers with associated peripherals. Table 2.1 lists the hardware and system software for the upgraded satellite processing facility.

As part of the GOAP program, NORDA is also supporting the development of an information processing system. Four stages will be involved in the development of the system: planning, implementation, demonstration and evaluation, and the operational phase. The developmental study for the information processing system took into account hardware/software and software/software interfaces, data queues, and data processing. A Conceptual Design Review was held in October 1982.

After launch of GEOSAT-A in FY-84, the hardware and software system will be used in an operational demonstration, which is intended to prove that oceanographic products can be derived from altimeter data in near-real-time. The first 6-12 months of the demonstration will be conducted at NORDA; subsequently, it will be transferred to FNOC.

Several organizations and locations are involved both in the operational demonstration and the preparation for it. The GEOSAT-A satellite will be built by the

Johns Hopkins University Applied Physics Laboratory (APL); the primary receiving site will be at APL. APL will perform some preliminary data processing and transmit the results to NORDA. (Satellite data dumps will occur about once every 12 hours.) NORDA will analyze the data to provide wind and wave information over open ocean areas every 12 hours, and information on mesoscale ocean features in selected areas every 24 hours. The calculations will require oceanographic fields and other oceanographic data to be transmitted from FNOC to NORDA. The results of the analysis will be transmitted from NORDA to FNOC according to the schedule given above. Both APL and Jet Propulsion Laboratory (JPL) were under contract to NORDA in FY82 to help prepare for this operational demonstration. The two laboratories have unique capabilities in complementary aspects of the problem. NRL is also providing assistance in sensor performance validation and similar areas. Computer Sciences Corporation (CSC), the on-site contractor, will provide support in detailed software design and implementation, and in specification of data link hardware and software. NORDA will manage the GOAP information processing system development, supported by several advisor/consultants.

2.2 Pretest Activity

2.2.1 Data Links

APL will transmit to NORDA a "NORDA Data Record" (NDR), which will be a data stream that consists of a header frame and multiple data frames. The NDR will be encrypted and transmitted to NORDA via a new 9.6 kb/s communication line. At NORDA the data stream must be decrypted and input to the SEL 32/27 computer system via an interface unit. A similar link will be required to transmit products from NORDA to FNOC. NORDA must also receive FNOC fields. That data volume is low compared to the GEOSAT-A data. Encryption/decryption are not required for fields of surface temperature and pressure, and surface water vapor pressure, but may be required for BT data. There is presently one 9.6 kb/s line between NORDA and FNOC; it is not certain that the existing line will be available for GOAP data transmission.

Hardware and software compatibility between the different sites is important. APL has procured the following SEL interface hardware: Model 9116 Binary Synchronous Line Interface Module (2 needed), Model 9103 General Purpose Multiplexer Controller, and Model 9305 General Purpose Device Controller Chassis. The total cost is approximately $10-$11K plus maintenance (the GSA discount would be applied to a government purchase). The data line (between APL and NORDA) will be specified to have technical performance equivalent to Dataphone Digital Service (DDS). Other communication link hardware required includes modems (FNOC uses Codex equipment) and encryption/decryption gear (to be provided GFE). APL will write communication software and provide it to NORDA. The transmission protocol will be (IBM standard) binary synchronous. NORDA is actively considering the details of specifying and obtaining a compatible system of communication hardware and software for both data links.

2.2.2 NORDA Satellite Receiving Facility and GOAP Data System

The NORDA RFP for a turnkey satellite receiving system was modified to specify that the processors used in the system would be two (GFE) Gould SEL 32/27 32-bit minicomputers, with one allocated for use by GOAP. That processor is expected to be available for use in August 1983.

The two Gould SEL 32/27 computers and associated peripherals and software, as described in Table 2.1, have been purchased. These processors will upgrade

the NORDA satellite processing facility to enable it to support GOAP and other NORDA research efforts. Additionally, GOAP will make use of satellite IR imagery obtained via the satellite receiving facility.

The previously described data links and the NORDA satellite receiving/processing facility are important elements in the GOAP information processing system. Other elements are the software modules that will process the information at NORDA. NORDA and its contractor(s) will design the software system to run on the NORDA GOAP computer. That effort will be described below. Plans for the APL GOAP software and its testing are described in the GEOSAT-A Ocean Applications Program APL/NORDA Data Link Program Plan (1982, 1983).

JPL's preliminary system-level plan for information processing development (1982) addresses two primary and two secondary functional requirements. The primary requirements are:

- Provide wind and wave reports every 12 hours to FNOC. Wind speed and significant wave height will be contained in the NDR and could be passed on with little (e.g., editing) or no processing.
- Provide a mesoscale oceanography analysis for selected areas every 24 hours to FNOC. As currently envisioned, this consists of subjective (analyst-produced) interpolated data sets of sea surface height for the most recent 30-day period. Some other (e.g., objective analysis) results may be available.

The secondary requirements are:

- Provide the capability to evaluate, and then enhance, the data products during the demonstration and evaluation phase.
- Provide the capability to determine system performance and assist in problem isolation in the complete end-to-end system (interface to mainline GEOSAT-A program, GOAP data processing system, FNOC data processing system, and the communications lines).

These functional requirements translate into requirements for several types of resources and capabilities:

- Interactive data recall, display, and manipulation capabilities.
- Software development tools and resources.
- Supporting data types such as composite infrared contour maps, bathythermograph data, and climatological data. (The details of this list remain to be clarified.)

The major milestones are listed in Figure 2.1 and described below. NORDA's on-site technical support contractor will implement most of the NORDA software. NAVOCEANO may provide some software modules. The contractor will also integrate the major software modules with each other, with the operating system, and with the hardware. APL's line control software will be provided to NORDA, along with assistance in conversion. NORDA will work closely with APL in the definition of the NDR. Plans for system testing and evaluation will be prepared by NORDA and its software contractor.

The schedule of activities must be coordinated with APL's schedule for development of (their portion of) the GOAP software and data link. That schedule,

which appears in their Data Link Program Plan (1982, 1983), calls for system (hardware and software) integration to be complete in March 1984. Some APL milestones that are closely tied to milestones for the NORDA site are also shown in Figure 2.1.

After launch of the satellite, approximately 30 days will be required for orbit stabilization, satellite system "health" verification, sensor data validation, etc. NORDA plans an additional 30-45 day test period after operational data transmission from APL begins to provide a preliminary operational evaluation of the information system.

SECTION 3. TEST AND EVALUATION

3.1 Test Plan

A data system test plan will be prepared by the software contractor by 1 February 1984 for review and approval by NORDA. This plan will specify precisely what constitutes an acceptable test at each of three testing levels:

(1) Stand-alone system testing.
(2) End-to-end interface testing.
(3) System performance testing.

The stand-alone system testing will verify that software and hardware have been successfully integrated and that they function properly in a stand-alone manner. The end-to-end interface testing will verify that data can be transferred between APL, NORDA, and FNOC as specified in the requirements. The system performance testing will verify that the system will produce "reasonable" products given accurately simulated altimeter data. NORDA is preparing a simulation employing SEASAT and GEOS-3 data, and NRL is responsible for preparing a "standard" test tape of GEOSAT-A-like data. Also, the timeliness and machine resource constraints will be verified with realistic simulation data.

The software contractor will prepare testing tools and plans, and then perform the testing. NORDA and its advisors will review the results. Testing should be complete by September 1984.

APL presents a plan for testing their portion of the GOAP information processing system in their Data Link Program Plan (1982, 1983). The only details shown there are for data link software verification and validation. Similar testing will be necessary for the FNOC portion of the system. That testing will primarily be the responsibility of FNOC personnel, with NORDA providing technical support.

3.2 Data System Operation and Evaluation

After launch the evaluation of the system will consist of an initial verification that the requisite data products can be produced on the specified time line, with real data. This will be followed by a comprehensive months-long evaluation of the data products.

The preparation of the data products themselves will be a complex procedure that involves the cooperative efforts of a number of people. Table 3.1 lists the major steps that will go into the production of the oceanographic data products. Figures 3.1.a and b show timing estimates for various stages of the process of turning raw data into products. It will be noted that some steps are keyed to data

transmissions from APL to NORDA (whose times depend on when the satellite is in view of the receiving station), while other steps are more conveniently performed at certain times of day. Each day, an analyst at NORDA will evaluate the daily product before transmission to FNOC. Also, copies of the data will be studied by other Navy and contractor analysts to assess the data in a more "off-line" mode. Every month a data product quality evaluation meeting will be held at NORDA where the problems and progress of the past month will be summarized and documented. This monthly product quality report will be prepared by both the "on-line" analysts working at NORDA and the "off-line" analysts working elsewhere.

Table 3.2 shows a "typical" 48-hour schedule for GOAP processing. It begins at noon (Central time) and arbitrarily assumes that a satellite data dump begins then. Data dumps will not occur exactly every 12 hours. Each interval will be different, but to a first approximation they will alternate between 9 hrs 40 min and 13 hrs 55 min. There will be some occasions when, because of the receiving station/satellite-viewing geometry, there will be insufficient time to receive all the data gathered since the last data dump. In such cases, the remaining data (plus that gathered since the partial dump) will be received on the next orbit. Such a situation is referred to as a "split pass" condition. Table 3.2 takes into account all of these factors.

3.3 System Integration and Testing

3.3.1 System Description

The portions of the overall GOAP system of primary interest to NORDA are communications link (APL-NORDA and NORDA-FNOC) hardware and software, and NORDA processing hardware and software. The communications link hardware consists of computer interface units, encryptors/decryptors, modems, and communications lines. The encryptors/decryptors are GFE and will be obtained by NAVELEX. The interface units, communications lines, and modems will be provided by the GOAP project. APL will write the communications software. The NORDA processing hardware is described in Table 2.1. It is being procured separately, funded in part by OP-952 FY-82 funds. The NORDA GOAP processing software will be developed as discussed in Section 2.2.2, and supported by GOAP (SOTA) funds.

The cost for a 9.6 kb/s private Bell System line between APL and NORDA was found to be $1350 per month, including conditioning. Modems can be either purchased or rented. A typical purchase price is $2795, while $210 per month is the rental cost. At present there is no DDS service to Bay St. Louis, Miss. One possible arrangement would consist of a 9.6 kb/s DDS line between Washington and New Orleans (rental charge $1070 per month), plus an analog line and modem between New Orleans and Bay St. Louis ($1512 per month); a non-recurring installation cost of $1204 would also be required. Aside from the higher cost, this system suffers from the drawback that the resulting signal quality from the combination is likely to be no better than that provided by an all-analog service. GTE Telenet is another option, although at somewhat higher cost ($3411 per month with a two-year contract). The charges for the NORDA-FNOC line should be similar (higher because of the increased distance). A saving should result if the existing NORDA-FNOC line is shared.

3.3.2 Personnel

During the planning and implementation phases, tasks will be performed by NORDA analysts and contractor personnel with NORDA coordination. APL will provide

technical support for the conversion of the line control software to NORDA's computer, for the procurement and installation of the 9.6 kb/s line and modems at APL and NORDA, and for the installation of the data line encryptor, decryptor, and Crypto Ancillary Unit (CAU) if needed. NORDA and its software contractor will be responsible for the design of the software system functional and detailed requirements. The software contractor will be responsible for the design and implementation of the computer software modules, for preparation of the system test plan, and for system testing. NORDA will also be assisted by several outside consultant/advisors, chosen for their unique capabilities and talents.

During the demonstration/evaluation and operation phases, the system will be operated by NORDA analysts and (a minimum of) two contractor personnel. The former will conduct the oceanographic analyses--primarily, detection and monitoring of mesoscale features, while the latter will perform the support tasks listed in Figures 3.1a and b. Normal operation will consist of two shifts, five days a week. The contractor personnel will work the second shift.

During this period the evaluation of the system will consist of an initial verification that the requisite data products can be produced on the specified time line, with real data. This will be followed by a comprehensive evaluation of the quality and utility of the data products. NAVOCEANO will cooperate with NORDA in the evaluation.

The quality of the data products will be evaluated by qualified oceanographic analysts working at NORDA and elsewhere. Each day analysts will determine that the products are in reasonable accord with data from satellite IR sensors, with XBT data, with data from previous altimeters (SEASAT and GOES-3), climatological data, with previous GEOSAT-A data, and with current mesoscale-resolving circulation models. In order to facilitate this evaluation the GOAP information processing system will have access to all the above-mentioned data types plus a wide variety of graphics and manipulative capabilities to recall, display, and merge current and historical data.

The utility of the data products will be evaluated primarily by analysts at FNOC and the regional centrals. Analysts at these locations will determine to what extent these GOAP data products can be used to generate improved FNOC "now casts" and forecasts in an operational environment. Likewise, the regional centrals will determine to what extent these data products are useful in preparing their own more specialized data products. Basically, the analysts at FNOC and at the regional centrals will determine whether or not their deliverables are improved through the use of GOAP data products. In some cases the GOAP data products may be directly useful to Navy line elements such as the P3 squadrons. In this case these users would be contacted for their response to the GOAP data products. The FNOC and regional central analysts will prepare a bimonthly report on GOAP data utility.

3.3.3 Orientation Plan

Orientation and training will be performed by three methods:

(1) On-the-job experience with the system acquired during pre-test development and operation of the system.
(2) Formal instruction on the system by the principal investigator and/or the information processing system contractor(s).
(3) Detailed written instruction in the form of a user's manual.

3.3.4 Testing

The different elements of the test procedures have been discussed in previous sections. It should be noted that the development of a detailed test plan is an important part of the information processing system development. Plans for system testing and evaluation are scheduled to be prepared by February 1984. Prior to launch, simulated GEOSAT-A data can be used in the testing. NRL has responsibility for preparing a simulated data tape using synthetic data. That tape is scheduled to be ready approximately April 1983.

3.3.5 Transition to FNOC

NORDA is committed to a 6-12 month operational evaluation with analysis to be performed at NORDA and results transmitted to FNOC. Subsequently, the processing itself will be transferred to FNOC. (This will necessitate a direct APL-FNOC data link.) The schedule for the transition will be keyed to the schedule for the FNOC Satellite Processing Center (SPC) upgrade. NORDA and its contractors will provide technical support to FNOC for the transition, and will strive to prevent any interruption of the analysis during that time.

Table 1.1 Significant actions, participants, and dates

	APL	Contractor(s)	FNOC	JPL	NAVELEX	NAVOCEANO	NORDA*	NRL	Regional Centers	Time Frame or Completion Date
Project Management							×			Continuing
Processing Software										
Conceptual Design				×						Dec 82
Prepare Simulated GEOSAT Test Tape								×		Apr 83
Provide Processing Hardware							×			Aug 83
Communication Software:										
Write	×									Aug 83
Provide to NORDA	×									Dec 83
Plan for FNOC Assimilation of Products		×	×				×			FY84
Communication/Crypto Gear:										
Coordinate Acquisition					×					Jan 84
Technical Support	×									
GOAP Processing Software		×				×	×			Jan 84
Processing System Testing:										
Prepare Plan		×					×			Feb 84
Perform Testing		×					×			Sep 84
Operational Evaluations:										
Initial						×	×			FY85 Q1 & Q2
Ongoing			×			×	×		×	FY85
Orientation & Training		×					×			FY85
Transition to FNOC		×	×				×			Mar-Sep 85

*NORDA will use several consultant/advisors who have expertise in specific areas.

Table 2.1 NORDA satellite processing facility system components

Item No.	Qty.	Model No.	Description
1	1	3428	SEL 32/27 with 1 MB MOS memory, CPU with floating point, IOP, 10 SelBUS + 5 MP BUS slots
2	1	3901	SEL 32/27 CPU Cabinet
3	1	3443	SEL 32/2750 with 1 MB MOS memory, CPU with floating point, IOP, 18 SelBUS + 8 MP BUS slots
4	1	3902	SEL 32/2750 CPU Cabinet
5	2	8610-2	Console CRT
6	3	9131	HSD Interfaces
7	1	9135	Intercomputer Bus Line - 50' Cable
8	2	8511	8 Line Asynchronous Mux
9	2	8580	RS 232 Distribution Panel for 8511
10	2	8140	Single 300 MByte disc with controller
11	1	8212	Single 125 IPS - 800/1600/6250 BPI tape drive with high speed controller
12	1	8290	High Speed Mag Tape Cabinet
13	1	1401-0201	MPX - Operating System
14	1	1411-0201	Scientific Runtime Library
15	1	1413-0201	Fortran 77+

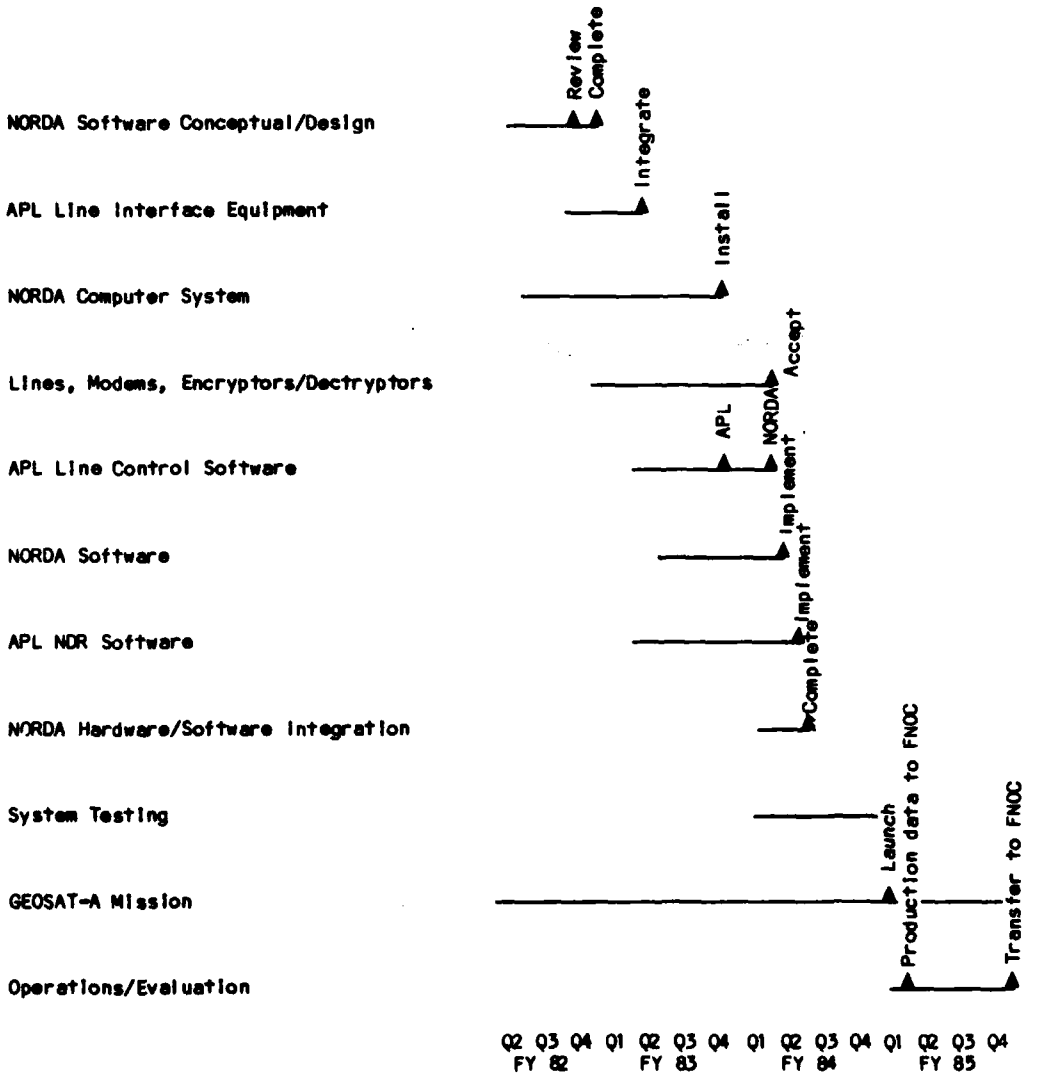
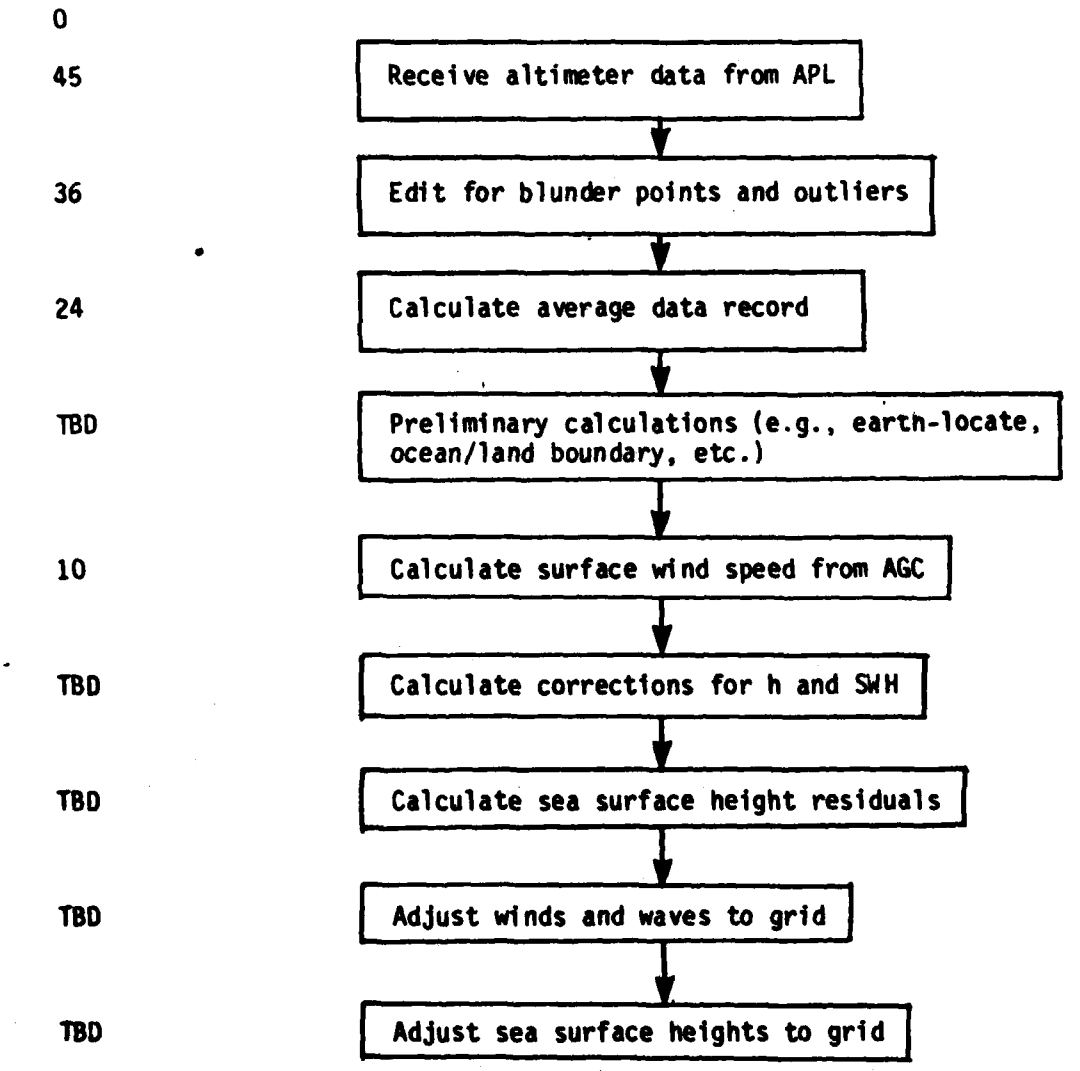


Figure 2.1 GOAP data system major milestones

Table 3.1 Operations performed at NORDA during demonstration and evaluation phase

- Receive and decypt GEOSAT-A altimeter data.
- Receive FNOC fields.
- Acquire satellite IR imagery (NORDA satellite receiving station).
- Perform editing and averaging of altimeter data.
- Apply sensor and geophysical corrections to altimeter data.
- Navigate and register satellite imagery.
- Prepare warmest-pixel composites from imagery; archive.
- Calculate surface wind speed and significant wave height from altimeter data; transmit to FNOC every 12 hours daily.
- Calculate sea surface height residuals from altimeter data; merge with warmest-pixel composites.
- Perform interactive analysis/interpretation using altimeter height residuals, IR composite imagery, other imagery (e.g., VAS), in situ measurements, historical data, to detect and track fronts and eddies.
- Prepare fronts and eddies chart, transmit to FNOC every 24 hours (M-F).



NOTES: 1) Timings are for 12 hours of altimeter observations.
2) Data processing for many of these operations is automatic (unattended).
3) Time estimates include data management steps.

Figure 3.1.A. Operations keyed to altimeter data reception

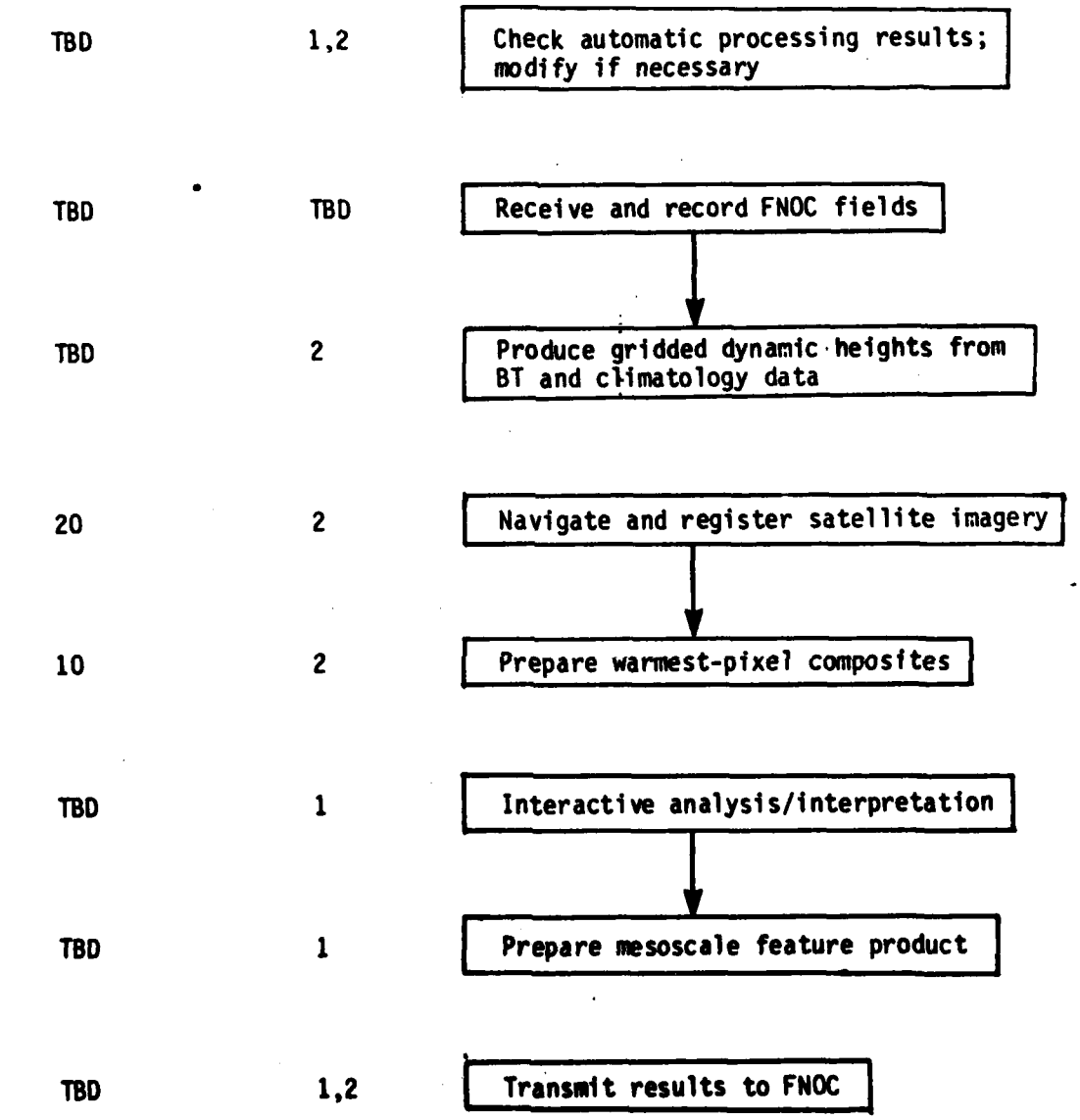


Figure 3.1.B. Operations keyed to times of day

Table 3.2 48-hour GOAP processing time line

NOTE: Time of day is Central Time. Schedule begins with a satellite data dump, (arbitrarily) starting at noon.

TIME FROM START	TIME OF DAY	EVENT
0000	1200	Data dump begins
0055	1255	NDR at NORDA
0155	1355	ALT processing done
0400-0430	1600-1630	Shift change
0430-1200	1630-2400	Prepare composites; other routine operations
1200	2400	Second shift begins
1355	0155	Data dump begins
1510	0310	NDR at NORDA
1635	0435	ALT processing done
2000	0800	First shift begins
2000-2400	0800-1200	Review results; make corrections; perform mesoscale analysis
2400-2800	1200-1600	Transmit mesoscale analysis to FNOC
2535	1135	Data dump begins
2430	1230	NDR at NORDA
2530	1330	ALT processing done
2800-2850	1600-1630	Shift change
2850-3600	1630-2400	Prepare composites; other routine operations
3600	2400	Second shift begins
3750	0130	Data dump begins*
3810	0210	(Partial) NDR computed
3910	0310	Data dump begins*
4025	0425	NDR at NORDA
4150	0550	ALT processing done
4400	0800	First shift begins
4400-4800	0800-1200	Review results; make corrections; perform mesoscale analysis
4710	1110	Data dump begins
4800	1200	NDR calculation in progress; begin transmission of mesoscale analysis to FNOC

*Split pass

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NORDA Technical Note 158	2. GOVT ACCESSION NO. AD-A126784	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) GEOSAT-A Ocean Applications Program (GOAP) Initial Data Processing and Analysis System Test and Evaluation Plan		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Matthew Lybanon		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Ocean Research and Development Activity NSTL Station, Mississippi 39529		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS P.E. 63704N
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Ocean Research and Development Activity NSTL Station, Mississippi 39529		12. REPORT DATE March 1983 13. NUMBER OF PAGES 14 16
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

GEOSAT-A Microwave altimetry
Test and evaluation Information processing systems

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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